SCHIZOPHRENIC PERFORMANCE ON SPEEDED CLASSIFICATION TASKS

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ABSTRACT

The response times of ten process schizophrenics, ten reactive schizophrenics and twenty non-hospitalised normal controls were compared on four speeded classification card-sorting tasks; control, filtering, grouping and condensation, which varied the ways in which visual stimuli could be assigned to one of two response classes. Results suggest that on tasks, such as filtering, which require the ignoring of irrelevant stimulus attributes for successful classification of stimuli, schizophrenic response times are slightly longer, but on tasks such as grouping and condensation which progressively increase the response selection demand aspects of visual information processing, schizophrenic response times are progressively increased by a much greater degree than are those of normals. The process and reactive groups did not differ on any measure.

CONTENTS

CHAPTER I

INTRODUCTION

This thesis reports an experiment which uses response time as a means of examining the ability of schizophrenics to process visually presented information. It bears directly on theories of cognitive deficit in schizophrenia (e.g. McGhie, 1970; Yates, 1966a, 1973) and results are discussed with reference to these.

A brief review of relevant cognitive deficit literature is now presented.

Cognitive processing has been described as an information flow that passes through an input stage, to a processing stage, and finally to a response stage (Neisser, 1967; Sternberg, 1970). Yates (1966a, 1966b), going from the work of Babcock (1930, 1933), and influenced by Broadbent (1958), suggested that the normal human organism he conceptualized as an information processing system capable of four stages of processing: (i) receiving an incoming stimulus; (ii) organising experience in a manner in which such stimuli can be acted upon; (iii) processing such information at a central level; (iv) executing a response on the basis of the outcome of this central processing.

Many investigations of cognitive deficit in schizophrenia have focussed on a breakdown in perceptual mechanisms and these could be conceptualized as disabilities in the early, input, stages of Yates' model.

For example, Venables (1964) suggested a link between arousal and attention: chronic and process patients are hypothesized as having supernormal levels of arousal which lead to restriction of the attentional field; acute and reactive patients suffer from subnormal arousal levels and a subsequent broadening and "flooding" of the range of attention.

Silverman (1964) formulated a theory based on the cognitive control variables scanning and field articulation, and hypothesized that acute paranoid and good premorbid patients are extensive scanners and closely articulate the field; and that acute nonparanoid and poor premorbid patients are minimal scanners and fail to articulate the field. Furthermore, these cognitive "styles" are reversed as the illness progresses.

Results from studies capable of confirming the Venables and Silverman models are equivocal and difficult to interpret (Neale and Cromwell, 1970) and Neale (1971) makes it clear that there is an ambiguous relation between such tasks as scanning and field articulation, and cognitive deficit.

McGhie (1970) elaborated upon these theories and emphasized the schizophrenic's inability to screen out task-relevant information due to an impairment of the normal filtering mechanism of attention as formulated by Broadbent (1958). A breakdown in filtering leads to overloading of the primary perceptual channel with both relevant and distracting stimuli, an overloading which causes failure to select out and thus to respond to relevant stimuli.

Yates (1966a, 1966b) departed somewhat from interference due to irrelevant stimuli, hypothesizing rather, a slowdown in processing capacity. Although he suggested that disability could occur at any one of the four stages in his model, he himself proposed the locus of retarded schizophrenic functioning to be at stage (ii), in data processing units, where incoming stimulus information is organized. In his system, sufficient relevant information fails to be processed rapidly and this leads to a crucial loss of stored information in short term memory (STM). Hence only a fragmentary part of the relevant information is successfully processed.

However, Broadbent's (1958) perceptual filtering model (on which McGhie's position is based) has been embarrassed in studies using normal subjects, and even the author himself has acknowledged its weaknesses (Broadbent, 1971). Studies of normal attentional processes (Gray and Wedderburn, 1960; Moray, 1959; Treisman, 1964) have led to the rejection or alteration of such a theory (Treisman, 1964). Even alternative, much modified input filtering models have been seriously challenged (Greenwald, 1970a, 1970b; Norman, 1969). The basic thrust of this evidence is that the meaning of certain types of stimulus input can be recognised even though that input was coming from a source to which subjects were not attending and thus, according to Broadbent (1958), blocked prior to semantic analysis. This evidence is troublesome for any model of cognitive deficit in schizophrenia which postulates filtering of the stimulus input prior to analysis or processing.

Of direct relevance to both McGhie's and Yates' theories are reaction time (RT) studies that have concentrated mainly on the manipulation of stimulus demands. The pervasive finding of RT studies in schizophrenia has been that schizophrenic patients, particularly nonparanoids who have been hospitalized for long periods, have much longer RT's than appropriate controls (e.g. Yates, 1973; Zubin, 1975). If schizophrenics have difficulty in processing relevant information then it is to be expected that the more relevant information there is to process, the greater the dysfunction will become relative to normal performance. Court (1967), Court and Garwoli (1968) and Karras (1967) have noted that to substantiate Yates' theory, the rate of increase in RT with stimulus complexity should be greater for schizophrenics than non-schizophrenics.

In a comprehensive review of RT studies with normals, Smith (1968) discussed factors known to affect RT. Important among these are the number of different stimuli used (stimulus uncertainty), the number of response alternatives used (response uncertainty) and the way in which stimulus and response are paired or "mapped". Card-sorting tasks and tasks where a key press or vocal response is made in response to a light, digit, auditory or tactile stimulus all fall within the general paradigm. In experiments using a 1:1 mapping between stimulus and response, a linear increasing relationship between RT and stimulus uncertainty, defined as the logarithm to base two of the number of stimulus alternatives, (Garner, 1962) has repeatedly been found. This appears true of schizophrenics as well (e.g. Court and Garwoli, 1968; Marshall, 1973; Slade, 1971).

Those RT studies using a 1:1 mapping have produced conflicting results. Karras (1967) found that schizophrenics were slower than controls on a simple and two-choice RT task, but that chronic schizophrenic performance did not deteriorate disproportionately in the more complex conditions. Court and Garwoli (1968) found no differential group effects in an experiment which extended the Karras study to greater levels of complexity. Using short stay patients and normal controls, and employing an arrangement of lights and keys, they found that increased stimulus uncertainty did not cause a disproportionate increase in RT between schizophrenics and normals.

On the other hand, Slade (1971), using a continuous card-sorting task based on Crossman (1953) with long stay patients and normals, found that with increased uncertainty the schizophrenic performance deficit became proportionately greater. However, with 1:1 mappings stimulus and response uncertainty covary as Marshall (1973) observed, and RT then provides a measure in which these two sources of uncertainty are confounded. Marshall compared schizophrenics, neurotics and penitentiary inmates on a continuous card-sorting task (using coloured symbols as stimuli), attempting to vary stimulus and response uncertainties independently. He found schizophrenic RT's to be disproportionately lengthened, relative to controls, with both increasing stimulus and response uncertainty. This experiment is difficult to evaluate because little detail of the stimuli used is reported, but Marshall did consider stimulus processing to be less of a problem than response selection for schizophrenics.

Another proposal of Yates (1966b) is that complexity of input information does not produce a relative deficit in schizophrenics unless presented under conditions where there is continuous pressure to respond. The card-sorting tasks used by Slade and Marshall provided this continuous pressure to respond, whereas the discrete RT tasks of Karras (1967) and Court and Garwoli (1968) did not. Thus, results from these studies are consistent with that aspect of Yates' theory.

Recent RT studies using visual information have cast doubts upon those theories (e.g. McGhie, 1970) which postulate perceptual deficit as an explanation of primary cognitive deficit in schizophrenia. Two studies have manipulated stimulus uncertainty while holding response uncertainty and stimulus-response compatability (Teichner and Krebs, 1974) relations constant. Russell and Page (1976) employed a task involving the separation of target from non-target elements in a visual display with schizophrenics and normal controls and concluded that schizophrenic RT's were not disproportionately increased relative to normals with increased display uncertainty.

Royer and Friedman (1973), using a similar type of task, found also that when memory load is minimal and compatibility and response selection demands are held constant there is no differential increase in RT between schizophrenics and normals with increasing stimulus complexity.

Knight (1975) in a series of studies of scanning behaviour in schizophrenia, using tasks involving selection of target elements from multi-element visual displays, showed that the manipulation of complexity of visual stimulus input produced no disproportionate increase in RT with increased stimulus demands relative to normals. These results were further supported by Consedine (1976) who used similar tasks.

The results of these studies are not consistent with Yates' slow processing theory, nor with McGhie's attentional deficit theory. The conclusion reached in these studies is that what constitutes the major difficulty for schizophrenics is not so much the organization of sensory stimulation into a recognizeable stimulus or into relevant or irrelevant, but rather, the task of selecting a response or executing the more central translation steps in moving from a recognized stimulus to an appropriate response.

Results similarly inconsistent with perceptual deficit theories as primary explanations of deficient schizophrenic functioning are to be found in several recent studies using auditory information. These studies have used dichotic shadowing tasks in which the subject is required to attend to information presented in one ear while ignoring distracting irrelevant information which is simultaneously presented in the other ear.

For example, Korboot and Damiani (1976), using binaurally presented pairs of digits and letters, as well as a signal detection task involving the sequential detection of information, found that while chronic nonparanoid schizophrenics were characterized by extreme slowness of perceptual processing, schizophrenics excluded information from the irrelevant channel as effectively as neurotic controls in both tasks. These results led the authors to conclude that irrelevant items are processed by schizophrenics to the point where they are sufficiently discriminated to be rejected as irrelevant - in contradiction of McGhie's defective filter theory. This conclusion has been reached in attentional studies with normal subjects (e.g. Norman, 1969).

Schneider (1976) used distracting information of varying topics in a similar dichotic shadowing task with delusional and non-delusional schizophrenics, and with non-psychotic psychiatric and normal controls. He found that the nature of the distracting topic had differential distracting effects on delusional schizophrenics and the other groups, and he suggested that attentional dysfunction in schizophrenia may be the product not of a breakdown of any of the mechanisms of attention but rather of an unusual manner of allocating attention (Kahneman,(1973).

Oltmanns and Neale (1975) using a dichotic shadowing task with series of digits as both distractor items and to-be-remembered items, found that schizophrenic deficit relative to normals appeared only in the presence of distractors and when the series of to-be-remembered digits reached a certain length. They suggested that distractors interfere with some process of attention which is required for efficient performance with longer strings of digits but which is unnecessary at a lower level of input.

The interpretations of results made in these studies are consistent with the conclusions of Knight (1975) who, following Kahneman (1973), suggested that the non-specificity of schizophrenic cognitive deficit evident from the literature, together with the apparent difficulty in separating stimulus and response complexities, points to support for a capacity theory explanation. Marshall (1973) argued that resorting to models which postulate a deficit at a specific stage of processing necessarily restricts our view. He argued that schizophrenic information processing capacities are clearly deficient compared with those of other subjects, and that this relative deficit is not isolated to any one aspect of processing.

In Kahneman's (1973) comprehensive theory of attention, processing capacity, mental effort and attention are regarded as synonymous. At any one time a finite supply of effort can be distributed, by means of an allocation policy, to a variety of ongoing activities which compete for the available supply of attention or capacity. Such a theory suggests three broad ways in which schizophrenic functioning could be deficient. Firstly the total supply of processing capacity or attention may be reduced as a function of schizophrenia, with deficit being more likely to appear on tasks which are more demanding of capacity for normals, and the deficit becoming greater with increased total demands. Secondly, while the capacity of schizophrenics may not be reduced, their allocation policy may be faulty, resulting in intermittent task specific deficits. And thirdly, the momentary capacity generated by schizophrenics may not rise sufficiently, or quickly enough to keep pace with fluctuating demands.

Thus, conclusions from recent literature suggest that the nature of cognitive deficit in schizophrenia may be best investigated by using a gradation of tasks which are known to increase the processing demands made of normals and which concentrate on response selection demands rather than on stimulus processing demands.

With respect to these requirements, a study by Gottwald and Garner (1972) is especially relevant. Using a speeded classification card-sorting procedure with normal subjects, and employing stimuli which varied on the two separable (Garner and Felfody, 1970) stimulus dimensions of form and colour, they varied the way in which stimuli could be assigned to one of two response classes by using tasks called filtering, grouping and condensation.

The speeded classification procedure used required that subjects sort a deck of stimulus cards into two piles, with time taken to sort the deck being used as a measure of information processing capacity or demand. Within a filtering task the cards are sorted according to two levels on a relevant dimension with added stimuli per response category being provided by having two or more levels on an irrelevant dimension. Posner (1964) called this task filtering because it requires that the subject filter out one dimension in order to classify stimuli properly. Thus filtering requires "attention to attributes" (Kahneman, 1973, p.98), or selective attention to relevant information while ignoring irrelevant information. As such, this task provides a pure measure of McGhie's defective filter theory, but unlike those tasks of Knight (1975) and Consedine (1976) does not involve the scanning of a stimulus field.

Within a grouping task the number of levels on a single relevant dimension is increased, with more than one level being assigned to a single response category. This task requires that the subject group two or more levels into each of the two response categories. Keele (1970) observed an increase in classification time for grouping as compared with a simple two-choice sorting condition.

Within a condensation task a second relevant dimension is used such that both dimensions must be evaluated before a correct response assignment can be made. Posner (1964) argued that this would require a greater classification time than filtering, a result which has been found in several studies (e.g. Fitts and Biederman, 1965; Morin, Forrin and Archer, 1961).

Gottwald and Garner (1972) found that for the dimensions of colour and form, filtering was easiest followed by grouping and condensation respectively, both of which were considerably more demanding than filtering. All three tasks took longer than a control task in which two stimuli differed on one dimension only. Because it has been demonstrated with normals that these tasks involve exclusion of irrelevant attributes and varying response selection demands they would appear appropriate for the purposes of studying information processing in schizophrenics. Accordingly, an experiment is reported which uses these tasks to investigate relative cognitive deficit in schizophrenia, and to also investigate the process-reactive schizophrenic distinction.

Process patients are those characterised by a relative lack of personality differentiation, poorly integrated premorbid personality, blunted affect and a relative absence of confusion. There is a marked absence of precipitating factors, insidious onset and poor prognosis. In comparison, reactive schizophrenics are characterised by a more normal, stable pre-psychotic personality, noticeable affective components, observable precipitating factors and a rapid onset of psychosis. There is marked confusion but prognosis is generally good (e.g. Valliant, 1964a).

The process-reactive distinction was chosen because there seems little doubt that there are clustering of attributes along a process-reactive continuum (Becker, 1959; Garfield and Sundland, 1966) and because rating scales exist for this dimension (e.g. Phillips, 1953) which allow ratings of patients on a continuum as well as consideration of discrete groups.

As noted by Knight (1975), the process-reactive distinction is preferable to the acute-chronic distinction for research purposes because the latter is often used to describe a phase of illness, and therefore researchers who take newly admitted patients clearly in an acute phase run the risk of including in their sample patients whose life history reveals them to be long-term process schizophrenics.

For the purposes of this experiment the Phillips (1953) premorbid scale was chosen which rates patients according to their premorbid social and sexual adjustment.

CHAPTER II

THE EXPERIMENT

This experiment employed a speeded classification card sorting procedure with four different tasks, each varying the way in which a number of stimuli could be assigned to a single response. These tasks are the same as those used by Gottwald and Garner (1972) but with a greater number of stimuli being employed in all but the grouping task.

A three-factor design was used, with repeated measures on two factors. The factors were: groups at four levels - a reactive schizophrenic group, a process schizophrenic group and two normal control groups; tasks at four levels - control, filtering, grouping and condensation; and occasions or trials, with two levels - each task was performed twice.

All measures were obtained from the sorting of decks of cards into two piles.

(i) STIMULI

The stimuli varied along the two separable stimulus dimensions of colour and form with a set of (4 colours x 3 forms) being used. The forms were circle, square and triangle with areas of $2.83cm^2$, $3.06cm^2$ and $1.89cm^2$ respectively, chosen to give approximately equal appearing areas. These forms were cut from coloured adhesive paper from the Letraset Pantone range, the colours having the following notation: Letraset Pantone green 348-A; blue 294-A; yellow 115-A; and red 185-A. Each stimulus was mounted on the centre of a white cardboard card 8.9cm wide by 6.3 cm high, and that side of the stimulus card was then covered by a fine layer of transparent adhesive plastic. This layer served to both protect the card and facilitate sorting by providing a smooth surface.

Nine decks of thirty cards were constructed; six control decks and one deck each for the filtering, grouping and condensation tasks. The stimulus dimensions, both perceptual and geometric, were the same as those used by Gottwald and Garner, except for the colours which were the closest available to the Munsell colours used by those authors.

(ii) THE EXPERIMENTAL TASKS

Each task required that the subject sort a randomly shuffled deck of thirty cards into two piles (fifteen in each) in as short a time as possible. The stimulus sets for each task and the ways in which the stimuli were assigned to one or other of the two response classes are described as follows. (See also Table 1).

(a) Control

Within each of the six control decks there were two different stimuli, fifteen of each type. These two stimuli differed in colour but had the same form, and the stimuli were assigned to response classes on the basis of colour. The decks were composed as follows:

1. yellow versus green triangles
2. red versus blue squares
3. green versus yellow circles
4. red versus blue triangles
5. yellow versus blue squares
6. red versus blue circles

(b) Filtering

Within the filtering deck there were six different types of stimuli (five of each type) varying along both the colour and form dimensions. There were two colours and three forms but the stimuli were assigned to the two response classes on the basis of colour alone, form being irrelevant to classification, i.e. red (circles, squares and triangles) versus blue (circles, squares, and triangles).

(c) Grouping

Within the grouping deck there were four different types of stimuli, all four types having the same form but different colours. The stimuli were assigned to the two response classes on the basis of colour - two levels per response class i.e. red and yellow circles versus blue and green circles. There were eight each of the yellow and green circles and seven each of the red and blue circles in the deck.

(c) Condensation

Within the condensation deck there were six different types of stimuli (five of each type) which varied along both the colour and form dimensions. There were three colours and three forms, and stimuli were assigned to the two response classes with both dimensions being relevant to classification i.e. red circles and triangles, and blue circles versus green triangles and squares, and blue squares.

TABLE 1.

Assignment of stimuli to response classes for each experimental task

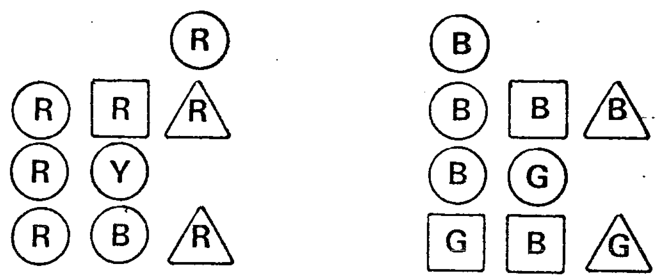
Left Pile — Right Pile

Control

Filtering

Grouping

Condensation



Within each task, apart from the grouping task, there were equal numbers of the different types of stimuli and as the decks were randomly shuffled the different types of stimuli had an equal probability of occurring next during sorting. Within the grouping deck it was necessary to have unequal numbers of each type of stimulus (albeit only a difference of one card in two types) to keep the total number of cards in the decks at a constant thirty. As this experiment is concerned with the differences in performances between groups on each task, and as each group performs the same tasks with each deck being in a different random order for each subject, the unequal numbers of stimulus types in the grouping task was not considered important.

(iii) PROCEDURE

Schizophrenic subjects were seen at the Psychology Department, Sunnyside Hospital, and prior to the experiment were given a brief interview during which any demographic data or personal history not on file was obtained. All subjects were seen individually and all were administered the Jastak and Jastak (1964) shortened version of the Wechsler Adult Intelligence Scale (WAIS) vocabulary subtest. During the experiment all subjects were seated at an empty desk facing a blank wall in an attempt to reduce stimulus distraction.

All subjects were put through the same sequence of thirteen trials. To familiarize subjects with procedure and stimuli, and to minimize the effects of practice in handling and sorting the cards in later trials, the first five trials were run as practice trials, using the first five control decks. The sixth control deck was used on the sixth and eleventh trials as a measure of two-choice response time - a base sorting task against which other tasks could be compared. Trials six to thirteen were ordered as: a b c c b a d d; where a, b, c and d refer to control, filtering, grouping and condensation tasks respectively. This sequence of trials allowed the effects of practise to be examined during the data analysis. All measures used in the analysis were from these trials. The addition of further control tasks was constrained by total experimental demand consideration as all subjects performed further speeded classification card sorting tasks after the thirteenth trial. That data is not reported here as it formed part of a separate project. Total experimental time ranged from forty-five to sixty-five minutes.

The experiment was begun with the reading of the following task instructions to the subject: -

> "These are decks of cards with thirty cards in each deck and with one coloured symbol on each card. With each deck some sample cards will be placed on the desk in front of you and in every case they represent all the different types of card to be found in that deck".
>
> (demonstrate with a control deck).
>
> "For example, this deck has two different types of card and you are required to sort the deck into two piles, one pile under each sample card, matching the symbol on the card you are sorting with the symbol on the sample card".
>
> (demonstrate).
>
> "You are to sort quickly as you can without making any mistakes. If you do make a mistake do not stop to correct it but carry on as I am more interested in how long you take than how accurate you are. The stopwatch will be used to see how long you take".

Subjects were instructed to hold the deck in a preferred hand and to sort with the other.

Similar instructions and demonstrations were given before the filtering, grouping and condensation tasks, using the appropriate sample cards which accompanied each deck. With the filtering and condensation tasks the sample cards were arranged on the desk in two triangular arrays of three, with a gap of one card's width separating the two arrays. The grouping task's sample cards were arranged into two groups of two cards in a straight horizontal line, again with a gap of one card's width separating the two groups..

The time taken (to within ± 0.1 sec) and the number of errors made were recorded after each trial and the deck randomly reshuffled if it was to be used again. At no time during the experiment was the subject told of his times or number of errors.

(iv) SUBJECT SAMPLES

Demographic details of subject groups are given in Table 2.

(a) Schiozphrenic sample

A sample of twenty patients was drawn from four admission wards at Sunnyside Hospital, Christchurch, New Zealand, during the period from June to December 1976. Patients were selected on the basis of Psychiatrists' diagnoses, case histories and Psychologists' observations. The diagnosis of schizophrenia was confirmed by the use of criteria defined by Astrachan, Harrow, Adler, Bauer, Schwartz, Schwartz and Tucker (1972) in the New Haven Schizophrenia Index. Patients were assigned to either a process or a reactive group, ten in each, according to their ratings on the Phillips (1953) Premorbid Scale. Details of patients' premorbid social and sexual adjustment were obtained from case histories, observations made by both Psychiatrists and Psychologists, and from brief interviews before testing if the previous sources were incomplete.

Although the Phillips Scale was designed for use with males it was also used with females in this study, although with minor modifications as in Farina, Garmezy, Zalusky and Becker (1962). The cut-off score for good/poor premorbid adjustment was fifteen - the good premorbid or reactive group having scores from one to fifteen inclusive, and the poor premorbid or process group having scores of sixteen and above. Although considerable variability is evident in the cut-off scores used, as Garfield and Sundland (1966) note, the score of fifteen is that most frequently used.

To avoid possible confounding effects due to length of institutionalisation (Strauss, 1973), subjects between the ages of eighteen and thirty years were used whose current length of hospitalization did not exceed six months. As subjects were on a variety of different medications, their daily drug regimens were converted into equivalent daily doseage of chlorpromazine, (phenothiazone drug index) as in Hollister (1970). Patients who had recently received electro convulsive therapy, or whose schizophrenic symptomatology was due to, or complicated by, organic or suspected organic etiology, were not included. Those patients who had secondary diagnoses (e.g. alcoholism, epilepsy or mental retardation), or who had been diagnosed schizo-effective, or who were in an acutely disturbed phase of their illness were also excluded.

Further, the testing of any subject who exhibited visual disturbances (e.g. the blurring of vision as a medication side-effect) or psychomotor difficulties at the time of testing was discontinued. Visual disturbances were screened for by asking potential subjects to read the wordlist for the WAIS vocabulary sub-test, and by presenting different stimulus cards and asking them if they had any difficulty in distinguishing between the stimuli. Psychomotor difficulties, such as violently trembling hands, usually became evident during the first few practise trials. For eight of the schizophrenic subjects, two independent ratings had been made of each of their scores on the Phillips scale. Inter-rater comparisons revealed that on six of the eight scores there was 100% agreement, while on the remaining two there was a difference of one point and five points respectively. These differences had no effect on placement of the two subjects in either the process or reactive groups as both were markedly process.

(b) Control sample

A sample of twenty non-psychiatric, non-institutionalised subjects was drawn from the general population. An attempt was made to match these in pair-wise fashion with the schizophrenic sample on the basis of: age, sex, verbal intelligence, educational and occupational status.

For the purposes of data analysis this sample was treated as either: two groups of ten subjects, normal 1 and normal 2, which acted as control groups for the reactive and process groups respectively; or, as a combined normal 1-

normal 2 (normal) group of twenty subjects which acted as a control group for the combined process-reactive (schizo-phrenic) group.

TABLE 2.

Subject Demographic Data

	Reactive	Process	Normal 1	Normal 2
Age				
Mean	23.60	22.30	23.60	22.90
S.D.	4.25	2.71	3.60	2.77
WAIS Vocabulary				
Mean	11.10	11.10	11.20	11.10
S.D.	2.73	1.85	2.62	1.85
Sex (frequency)				
Male	6	7	6	7
Female	4	3	4	3
Phillips Score				
Mean	12.10	20.10		
S.D.	2.73	2.23		
P.D.I.				
Mean	590.00	810.10		
S.D.	288.48	628.92		
C.H.L.				
Median	30	26		
Range	20-117	8-126		
P.A.				
Median	1	2		
Range	0-2	0-4		

P.D.I. = phenothiazine drug index

C.H.L. = length of current hospitalization (days)

P.A. = number of previous admissions

CHAPTER III

RESULTS

Subjects sorted each deck on two occasions. The mean sorting time, averaged over these two occasions, was found for every subject in each task. The means and standard deviations of these averaged sorting times together with the probability that a card was erroneously sorted are given in Table 3 for each group and task. See also Figure 1.

Examination of sorting times indicates that these were greater for schizophrenics, that the tasks lay in order of increasing difficulty from control to filtering to grouping and finally condensation, and that the rate of increase in sorting time with task was greater for schizophrenics.

The significance of these trends was assessed by a groups x tasks analysis of variance in which the between groups and groups x tasks interaction variance was partitioned into the orthogonal contrasts of: process versus reactive; normal 1 versus normal 2; and combined process-reactive (called schiozphrenic) versus combined normal 1-normal 2 (called normal). A summary of the results of this analysis is presented in Table 4. This and following analyses of variance were computed using the Biomedical Statistical Package BMD 08V program.

Examination of Table 4 reveals that only the schizo-phrenic-normal contrasts reached significance. The schizophrenic-normal, tasks, and schizophrenic-normal x tasks F ratios were all significant beyond the 0.001 level, supporting the trends observed in Table 3 and Figure 1.

With respect to errors, Table 3 indicates that these were rare, perhaps more frequent for schizophrenics, and more common in the grouping and condensation tasks. Their low frequency of occurrence precluded statistical comparisons. If subjects followed a speed-accuracy trade-off (Pachella, 1974), then, because errors were more prevalent for the slower schizophrenic groups in the more difficult tasks, it is likely that the present results underestimate the sorting times of schizophrenics, particularly in the more demanding grouping and condensation tasks.

In order to assess the differential group effects of the experimental tasks of filtering, grouping and condensation on sorting time, three separate groups x occasions x tasks analyses of variance were performed, these in turn including the tasks of control and filtering, control and grouping, control and condensation. As in the groups x tasks analysis of variance, between groups variance was similarly partitioned into the orthogonal contrasts, as was the variance for interactions of groups with occasions, groups with tasks, and groups with tasks x occasions. Again, the only contrast to reach significance in these three analyses was that of schizophrenic-normal.

Filtering

A complete summary of the results of this analysis of variance is given in Table 5. Examination of F ratios (1, 36, df) shows the following:

a significant groups main effect ($p<0.001$); a significant occasions main effect ($p<0.001$); and no significant groups x occasions, occasions x tasks or groups x occasions x tasks interaction effects. This indicates that for sorting times in both the control and filtering tasks combined, schizophrenics were slower and sorting times for all subjects were greater on the first occasion than on the second.

The tasks main effect was significant ($p<0.01$) but a borderline groups x tasks interaction effect ($p<0.05$) indicated a differential increase in sorting time between groups in the filtering task. A tasks effect was calculated separately for the schizophrenic group (but within this, treating process and reactive as separate groups) and for the normal group (with normal 1 and normal 2 as separate groups), using error terms derived from each analysis separately, not the pooled tasks x subjects within groups error terms from Table 5. This gave $F(1, 18) = 7.61$, $p<0.025$ for schizophrenics and $F(1, 18) = 2.45$, $p>0.10$ for normals.

To evaluate the relative size of this effect for each group, the variance component (Kirk, 1968, p.134) of the tasks effect (control-filtering) was calculated for schizophrenics (2.56) and for normals (0.04).

These results indicate that the introduction of an irrelevant stimulus attribute increases the sorting time of schizophrenics but not normals.

<u>Grouping</u>

A complete summary of results for the groups x occasions x tasks analysis is not reported as the analysis of variance model is identical to that in Table 5.

The schizophrenic-normal main effect and the occasions main effect were both significant for this task, with respective F ratios being $F(1, 36) = 25.69$, $p<0.001$, and $F(1, 36) = 24.81$, $p<0.001$. However, there was a borderline groups x occasions interaction effect, with $F(1, 36) = 5.146$, $p<0.05$, and to investigate this, separate graphs were drawn of change in sorting time across occasions for both the schizophrenic group and the normal group, in both the control and grouping tasks. All lines were of negative slope and all were near parallel, except that of the schizophrenic group in the grouping task. This line had a slightly greater negative slope than the others, indicating a slightly greater practise effect for schizophrenics in the grouping task. Because this interaction effect was barely significant, it was discounted as having a major contributing effect on the significance of the groups x tasks interaction for this task. Support for this assumption comes from the lack of significant occasions x tasks or groups x occasions x tasks interaction effects.

The tasks main effect was significant, as was the groups x tasks interaction effect, with respective F ratios being $F(1, 36) = 67.69$, $p<0.001$, and $F(1, 36) = 11.61$, $p<0.01$. A tasks effect was calculated for both the schizophrenic groups and the normal groups in a manner identical to that outlined for filtering, with resultant F ratios being $F(1, 18) = 37.75$, $p<0.001$, and $F(1, 18) = 56.05$,

$p<0.001$, respectively. The variance component for the grouping task was 12.77 for the schizophrenic group and 2.21 for the normal group.

These results indicate that although sorting times increased for both groups in the grouping task relative to those in the control task, the increase for schizophrenics was greater than for normals.

Condensation

As with the analysis of variance for the grouping task, a full summary of results is not reported as the model and analysis was identical to that used for filtering.

For the groups x occasions x tasks analysis, the schizophrenic-normal effect and the occasions main effect were both significant in this task, with respective F ratios being $F(1, 36) = 24.25$, $p<0.001$, and $F(1, 36) = 44.53$, $p<0.001$. There was no significant groups x occasions interaction effect and thus these results indicate that for sorting times in both the control and condensation tasks combined, schizophrenics were slowest and sorting times for all subjects were faster on the first occasion than on the second.

However, there was a significant tasks x occasions interaction effect, with the F ratio being $F(1, 36) = 13.085$, $p<0.01$. Graphs were drawn of mean sorting time for all subjects on each occasion, in both the control and condensation tasks. These indicated a greater practise effect in the condensation task than in the control task, but as this was true for all subjects, and as there was no significant groups x tasks x occasions interaction effect, the tasks x occasions interaction effect was considered not to have altered the significance of the groups x tasks interaction for condensation.

The tasks main effect was significant, as was the groups x tasks interaction effect with F ratios being $F(1, 36) = 161.016$, $p<0.001$, and $F(1, 36) = 15.083$, $p<0.01$, respectively. Separate task effects were calculated (as for filtering and grouping) for the schizophrenic group and the normal group and the resultant F ratios were $F(1, 18) = 80.92$, $p<0.001$, and $F(1, 18) = 128.11$, $p<0.01$, respectively. The variance component for the condensation task was 77.07 for the schizophrenic group and 21.86 for the normal group.

These results indicate that the sorting times of both groups increased on the condensation task, relative to those on the control task, with the increase being greater for schizophrenics than normals.

In summary, these results show differential group effects on all tasks, with the increase over control sorting time in the filtering, grouping and condensation tasks being greater for schizophrenics than normals. These differential group effects became greater on tasks which themselves became more demanding for normals.

Correlational Analysis

Finally, a difference measure was calculated for each subject in the filtering, grouping and condensation tasks by subtracting the mean sorting time in the control task from the mean sorting time in each of these tasks. These difference measures provided an indication of the extent to which an individual subject's sorting time was increased over his control sorting time by the increased processing demands of the filtering, grouping and condensation tasks respectively.

Product-moment correlations were then calculated between these difference measures and the subject variables for both the schizophrenic group and the normal group. Age and vocabulary score were the variables for the normal group, and these in addition to the Phillips score and the Phenothiazine drug index were the variables for the schizophrenic group. None of the correlations (with 18 df) exceeded the value of 0.445, the value required for significance at the 0.05 level. Clearly, no simple relation between subject variables and filtering, grouping and condensation effects is evident.

The correlation between the Phillips scores and the drug indices were similarly calculated for the schizophrenic group, and this was non-significant. In order to determine whether the subject variables for the schizophrenic group (particularly the Phillips score) were predictive of performance in the filtering, grouping and condensation tasks, a Multiple Regression analysis was conducted, using the difference measure as the dependent variable in each task and including sex as an additional predictor. The results for each task were as follows: filtering, $R = 0.62$, $F(5, 14) = 1.71$, $p < .20$; grouping, $R = 0.41$, $F(5,14) = 0.57$, $p < .72$; condensation, $R = 0.66$, $F(5, 14) = 2.21$, $p < .11$. None of these were significant. Thus none of the subject variables for the schizophrenic group can be considered predictors of time involved in filtering, grouping and condensation.

TABLE 3.

Group sorting times and probabilities of an erroneously sorted card per task

Groups	Tasks: Control	Filtering	Grouping	Condensation
Reactive				
Mean	20.15	21.72	25.95	33.30
S.D.	5.04	5.49	6.16	5.86
Probability of an error	0	0.010	0.017	0.023
Process				
Mean	20.82	24.12	25.28	32.67
S.D.	7.25	10.17	7.90	12.99
Probability of an error	0.003	0	0.037	0.063
Normal 1				
Mean	15.11	15.48	17.41	21.49
S.D.	2.62	3.19	3.55	3.97
Probability of an error	0	0	0	0.037
Normal 2				
Mean	13.55	13.89	15.86	20.45
S.D.	1.31	1.40	1.66	3.52
Probability of an error	0.003	0	0.010	0.023

Figure 1.

Group mean sorting time per task

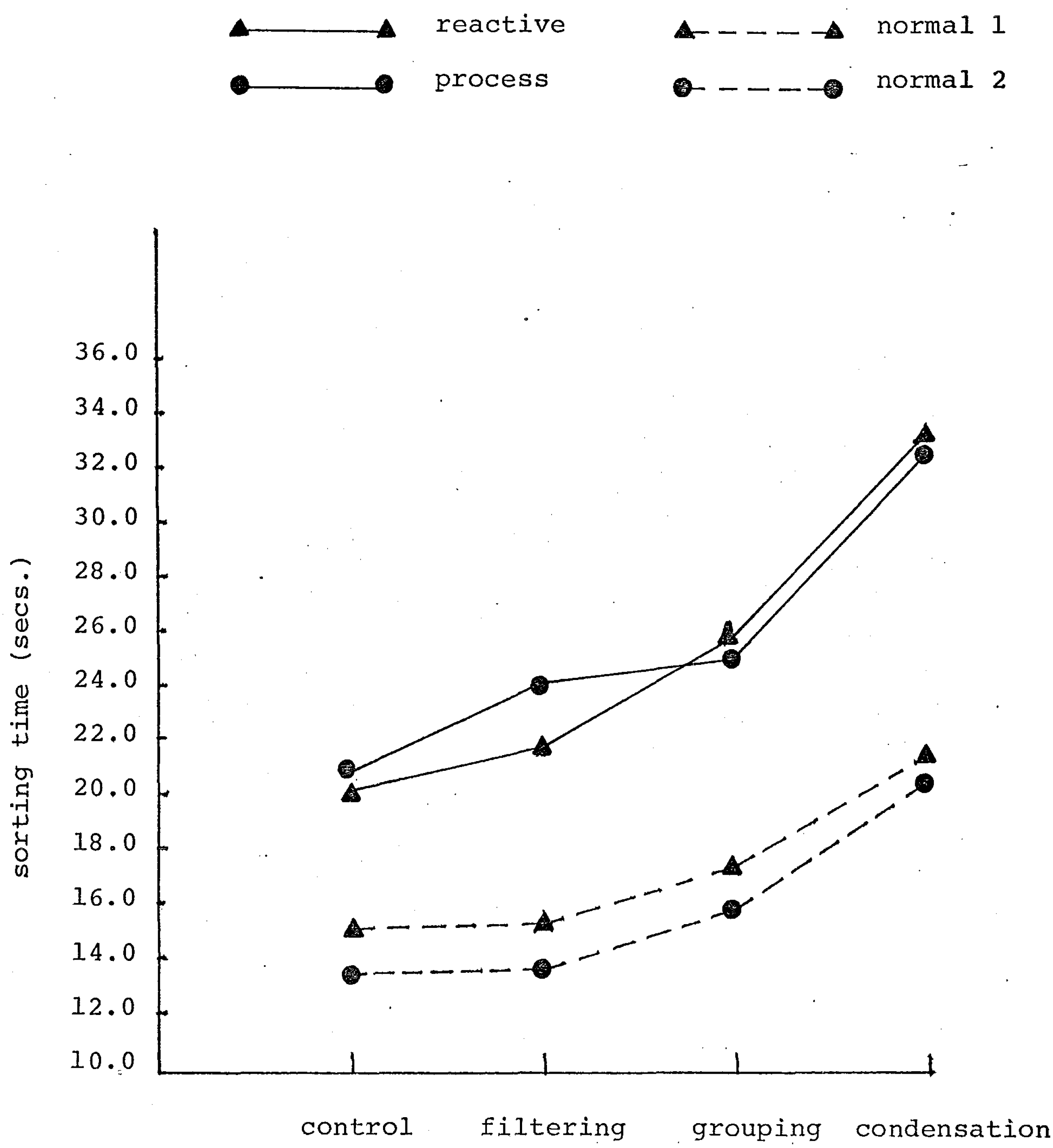


TABLE 4.

ANOVA Summary Table:

Increase in sorting time with task

Source	SS	df	MS	F
Between groups				
reactive-process (R-P)	3.94	1	3.94	0.03
normal 1-normal 2(N1-N2)	41.26	1	41.26	0.33
schizophrenic-normal (S-N)	3131.13	1	3131.13	25.20***
Ss within groups	4472.25	36		
Within Subjects				
tasks (T)	2136.80	3	712.27	103.98***
R-P x T	31.45	3	10.48	1.53
N1-N2 x T	1.03	3	0.34	0.05
S-N x T	176.48	3	58.83	8.59***
T x Ss within	740.37	108	6.85	

*** $p<0.001$

TABLE 5.

ANOVA Summary Table:

Increase in sorting time within the filtering task

Source	SS	df	MS	F
Between groups				
reactive-process (R-P)	47.28	1	47.28	0.44
normal 1-normal 2 (N1-N2)	49.46	1	49.46	0
schizophrenic-normal (S-N)	2072.16	1	2072.16	19.217***
Ss within groups	3881.98	36		
Within subjects				
tasks (T)	77.28	1	77.28	9.371**
R-P x T	15.05	1	15.05	1.82
N1-N2 x T	0.01	1	0.01	0
S-N x T	43.06	1	43.06	5.221*
T x Ss within	296.91	36		
occasions (o)	71.02	1	71.02	8.638**
R-P x o	0.001	1	0.001	0
N1-N2 x o	0.07	1	0.07	0
S-N x o	13.22	1	13.22	1.608
o x Ss within	295.99	36		
o x T	4.83	1	4.83	0.904
R-P x o x T	0.00	1	0.00	0
N1-N2 x o x T	0.38	1	0.38	0
S-N x o x T	1.02	1	1.02	0.192
o x T x Ss within	192.21	36		

* $p<0.05$

** $p<0.01$

*** $p<0.001$

CHAPTER IV

DISCUSSION

The four speeded classification card-sorting tasks used in this experiment were effective in varying processing demands made of subjects, with the result that schizophrenic sorting times were lengthened by a progressively increasing amount relative to control sorting time by the filtering, grouping and condensation tasks. Within the schizophrenic group, scores on the process-reactive continuum failed to be predictive of times taken in filtering, grouping and condensation, and there was no significant process-reactive group distinction on these effects.

For normals, sorting time relative to control was not lengthered significantly by the filtering task, but like schizophrenics their times were lengthened markedly by the grouping and even further by the condensation task.

With the exception of filtering with normals, these results are in agreement with those of Gottwald and Garner (1972) who obtained a small but barely significant ($p<0.05$) filtering effect and marked grouping and condensation effects with normal subjects.

Within each of the four tasks, schizophrenic sorting times were longer than those of normals, a finding consistent with those of many RT and card sorting studies (e.g. Yates 1973) in which schizophrenics are characterized by a slowness of functioning. Within the filtering, grouping and condensation tasks, differential group effects were assessed using increments in sorting time relative to control sorting times, rather than using absolute sorting times. In using this method it was assumed that between-group constrasts would be independent of groups' base sorting speed and thus independent of characteristic group differences found on simple RT tasks.

Thus, the greater rate of increase in sorting time for schizophrenics found across these three tasks indicates that schizophrenics dealt less effectively with the processing requirements of the tasks than did normals. As stimulus and response uncertainties (as defined by Smith, 1968) remained relatively constant across the filtering, grouping and condensation tasks, it seems reasonable to assume that it was the increments in response selection demands, or in the central translation steps (Teichner and Krebs, 1974) involved in moving from a recognised stimulus to an appropriate response, which proved disproportionately difficult for schizophrenics.

These findings are consistent with those of Marshall (1973), who found "stimulus analyzing" to be less of a problem than response selection for schizophrenics, and also with those of Venables (1965) who found that when stimulus complexity was held constant, schizophrenic RT's were more greatly slowed by increasing response complexity than were those of normals. These findings also provide verification of the predictions made by Russell and Page (1976) and Royer and Friedman (1973) who found no differential group effects on tasks which manipulated stimulus processing demands.

The fact that there was a small filtering effect for schizophrenics but not for normals in this study can provide only minor support for McGhie's (1970) "defective filter" hypothesis. As a primary explanation of schizophrenic deficit, it is not upheld by results on the grouping and condensation tasks as these two tasks respectively diminish the amount of irrelevant information involved in correct classification of stimuli into response categories. Furthermore McGhie's hypothesis would predict a greater number of errors on the filtering task for schizophrenics due to an overloading of STM with distracting information, but the error rates obtained do not support this prediction.

Yates' (1966a, 1966b) theory suggests that schizophrenics are abnormally slow at processing relevant information, and that abnormalities of functioning occur at the level where peripheral stimulus information undergoes primary and basic organization. Further, he contended that schizophrenic deficit will only show under a continuous pressure to respond. His theory is not upheld by these results insofar as stimulus complexity remained relatively constant over the three experimental tasks, but results do show schizophrenics to be slower than normals and deficit to occur under a continuous pressure to respond. His theory may, however, be compatible to some extent with the filtering effect for schizophrenics in that the filtering task represents a small increase in stimulus complexity over that of the control task, as well as an increase in stimulus-response mapping and a decrease in stimulus-response compatability (Teichner and Krebs, 1974).

Yates' theory would also predict a greater number of errors for schizophrenics, as over any period of time stored information in STM would be lost in greater amounts due to schizophrenics' slowness of functioning. Although error probabilities tended to be perhaps a little greater for schizophrenics on the grouping and condensation tasks, the fact that statistical comparison was precluded by the rarity of errors does not allow verification of this prediction.

Memory load imposed upon subjects increased across the control filtering, grouping and condensation tasks respectively, and this could be considered to cause differential group effects. However, Consedine (1976), employing visual search tasks which required that subjects identify one of several memorized target letters embedded in displays of varying numbers of non-target letters, found that no differential group effects between schizophrenics and normals were produced by increase in response time with memory load. Similar results were obtained by Royer and Friedman (1973).

While in this study response selection demands were manipulated to produce differential group effects between schizophrenics and normals, it appears that under certain experimental conditions schizophrenics may experience difficulty at both the stimulus and response ends of the processing system (e.g. Marshall, 1973). Knight's (1975) contention that the non-specificity of schizophrenic deficit lends support to explanation in terms of Kahneman's (1973) capacity theory, in that such a theory does not postulate a priori any particular aspect of processing being deficient, is consistent with such findings and with present results. Within the context of this study, relative schizophrenic deficit has appeared on those tasks, grouping and condensation, which themselves increased processing demands for normals, and on the filtering task which did not prove more demanding for normals than the control task but which did require attention to attributes.

Kahneman (1973), after reviewing work on the normal attentional processes, commented that "Attention to attributes affects the post-perceptual stage of response selection by increasing the readiness to produce codes of the relevant dimension (e.g. colour, words), and the tendency to attach overt responses to such codes" (p.111). He concluded that there is little evidence that an intention to attend a particular dimension of experience can prevent the perceptual interpretation of other dimensions (in direct contrast to Broadbent's (1958) perceptual filter theory).

Thus, within the terms of Kahneman's capacity theory, if schizophrenics have a faulty allocation policy or a reduced capacity as suggested by Knight (1975), then deficit can be expected to show up on tasks such as filtering, which requires selective allocation of capacity or attention to attributes, and on tasks such as grouping and condensation which themselves are more demanding of capacity for normals, particularly with respect to response selection aspects. The results of this study lend themselves to such an interpretation.

Conclusions and Directions for Future Research

A desirable feature missing from this study was a 'return-to-baseline' control task located after the two condensation tasks in the sequence of trials. This would have provided a clearer indication of any differential group practise effects which may still have been operating at that stage. As noted earlier, however, total experimental demand considerations in the collection of data for this study militated against such an extra trial.

Although results indicate that manipulation of response selection demands produced a differential rate of increase in sorting time with task demand between schizophrenics and normals, further research is needed to investigate more precisely why the tasks used produced such results. If, as suggested, cognitive functioning is viewed from a capacity theory viewpoint, then grouping and condensation may prove to have produced relative schizophrenic deficit because there are various strategies available to subjects which facilitate sorting, but which require either greater processing capacity, or a more complex allocation of capacity.

For example, Garner (1974) distinguishes between optional and mandatory processing mechanisms, maintaining that the human organism may have an option in how it uses properties of stimulus dimensions. Examples of optional processing mechanisms are: selective serial processing, whereby the organism processes one dimension before the other, but does so selectively so as to maximize performance; and stimulus redefinition, whereby the organism may redefine the stimuli so that a new dimension, which is more discriminable than either dimension alone, is provided.

Some of the normal subjects in this study reported using the latter strategy on the grouping task, using brightness as a dimension to transform the task into a two choice sorting task.

Another possible processing strategy is that of focussing (e.g. Gottwald and Garner, 1972) where the subject focusses attention on just one set of stimuli, the positive set, and then decides whether a stimulus belongs to that set, rather than deciding in which of two sets a stimulus belongs. Such a strategy is possible on the condensation task, and indeed its use was reported by some normal subjects.

The use of these strategies would require feedback in the information processing system from the response selection levels to the stimulus organization levels, and this would require extra capacity. If schizophrenics suffer reduced capacity or if their allocation policies are faulty, they may be precluded from using such strategies facilitatively.

The investigation of these strategies in the present study would not have been appropriate as it was not known beforehand that differential group effects existed on the tasks used. However if research is to be continued along the lines followed in this study, then the use of these strategies requires further investigation.

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